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(56) Documents Cited
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WO 98/31067 A **JP 100041734 A** **JP 090046121 A**
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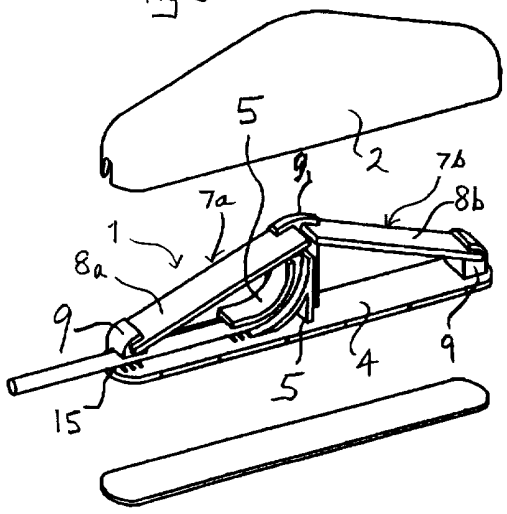
(54) Abstract Title
Antenna

(57) A dual frequency antenna comprises a housing 2 having a base 4 adapted to attachment to a vehicle windscreen. Antenna elements 7A,7B forming dipoles are supported within the housing 2 to define an included angle of approximately 140° (angles between 120 and 180 are also described). The elements 7A, 7B comprise dipole elements 21, 22. A coaxial cable 13 having inner and outer conductors coupled to the antenna elements 7A and 7B at their apex is routed in spaced relation to the element 7A connected to the inner conductor, in such a manner that currents tending to be induced in the outer conductor of the coaxial cable are canceled as a result of the proximity of the cable 2 to the element 7A. This enables the coaxial cable to be matched to the impedance of the antenna. The antenna is particularly suited for use with mobile phones and the like.

Fig 3



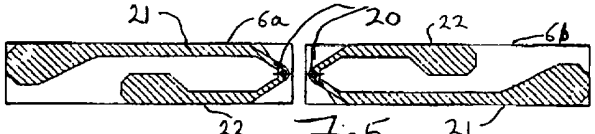


Fig 5

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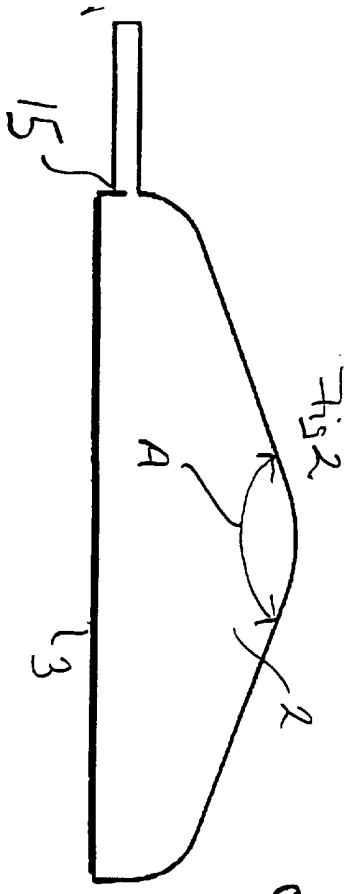

Fig 2

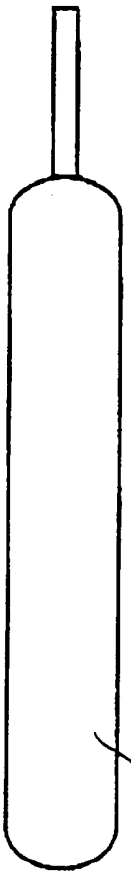

Fig 1

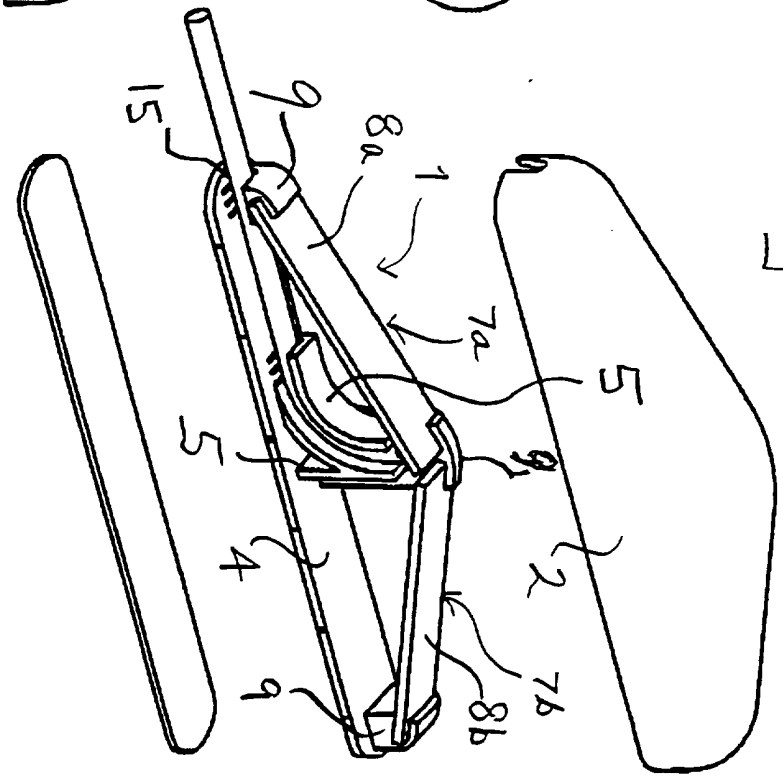

Fig 3

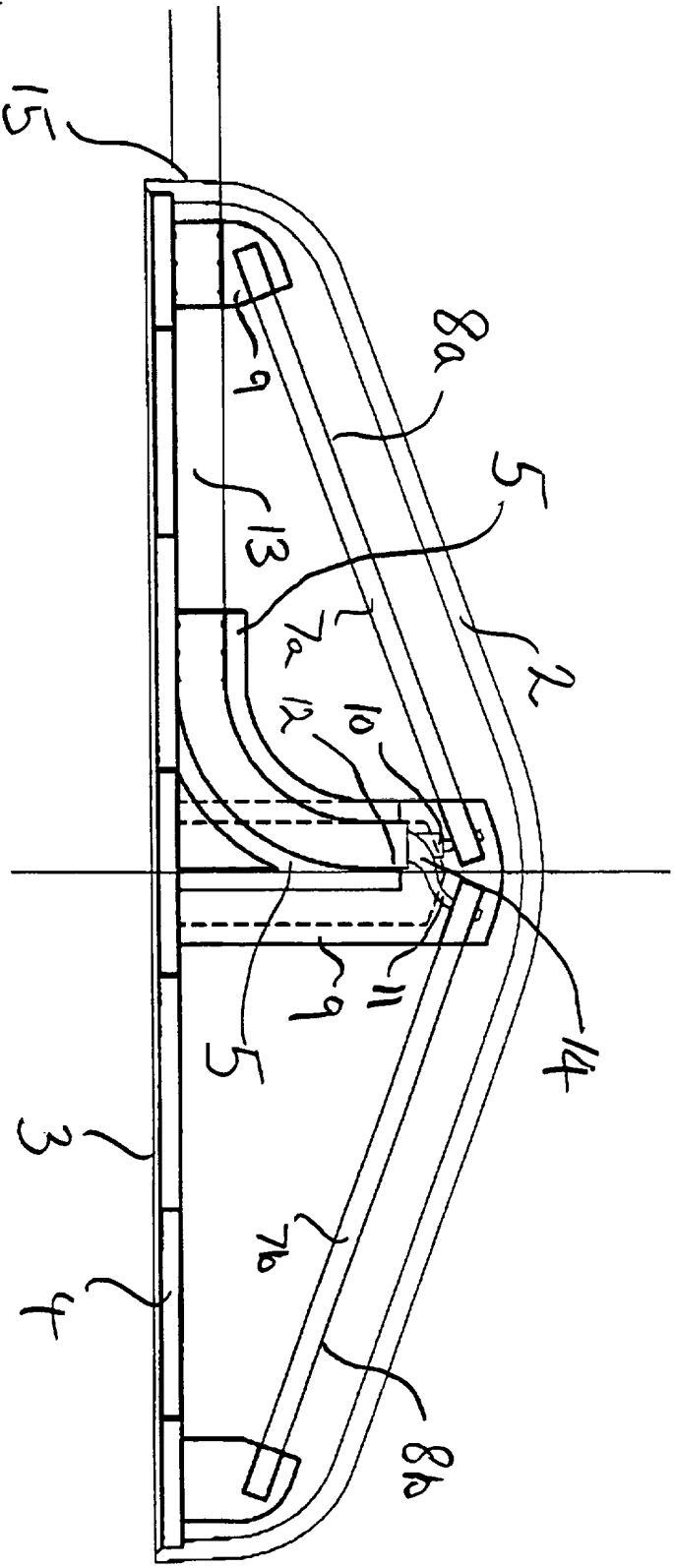

Fig 4

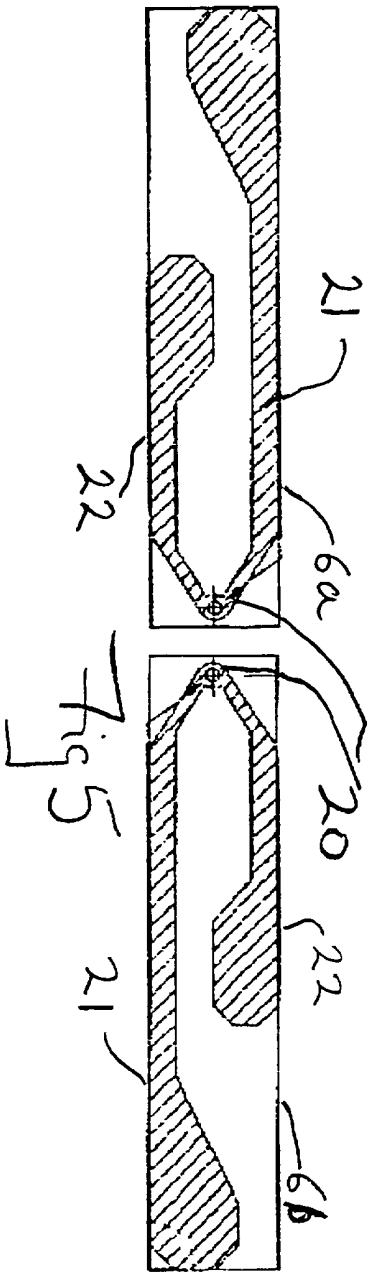

Fig 5

Antenna

The present invention relates to a mobile antenna for use in a motor vehicle, particularly, although not exclusively, for use with cellular telephony networks.

It is well known to utilise a unitary multi-frequency antenna in place of a set of physically separate antennas each operating in a different frequency range. Such an antenna provides advantages in a number of areas such as cost, practicality and aesthetics. For example, multi-frequency dipole antennas are commonly used in cellular telephony where the antenna is usually fed via a coaxial cable. In order to correctly feed such an antenna it is necessary to match the impedance of the cable and antenna otherwise the resulting currents flowing in the cable will cause it to radiate thereby interfering with the radiation pattern of the antenna. Typically, a balun or balanced to unbalance transformer is used to effect the impedance matching necessary. Disadvantageously, the need for a balun increases the overall cost of the antenna and perhaps more importantly substantially increases the potential for product failure during manufacture. Furthermore, it has been found that the performance of the antenna is dependent on the correct installation.

According to the present invention there is provided a dipole antenna for mounting on a vehicle windscreen, the antenna comprising a housing which includes a base surface intended for mounting on the windscreen, the housing containing first and second antenna elements each having limbs spaced from said base surface, said elements being so arranged that the limbs thereof cooperate to form dipoles having different resonant frequencies, and a coaxial cable having inner and outer antenna feeds respectively connected to said first and second elements which cable extends between said base surface and said first element in spaced relation to the latter in such a manner that electric currents that would occur in the outer feed of said coaxial cable due to mismatching of the impedances of the cable and the antenna elements are cancelled as a result of the proximity of the cable and the first antenna element.

Preferably, each antenna element is formed on a separate printed circuit board.

Advantageously, the printed circuit boards may be identical so as to simplify manufacture and reduce costs. The coaxial cable may extend beyond the antenna for connection to a communication device such as a cellular telephone or it may terminate at the housing in a connector to which a further length of cable may be connected. The housing is preferably all encompassing and conveniently provided with internal projections for routing the cable relatively to the first antenna element.

According to one embodiment of the invention the respective planes of said antenna elements intersect at an included angle that defines an apex extending away from said base surface. This improves the radiation pattern of the antenna in such a manner that operation of the antenna on a sloping automobile windscreen is significantly improved, particularly in the case where the antenna is mounted for use with vertically polarised signals as is conventional with current cellular telephone signals. In this case the coaxial cable is routed in a plane substantially normal to the planes of the dipole elements in such a manner that the cable extends from the dipole elements at said apex, along an axis bisecting said included angle and is then angled to extend along the base of the housing below the first dipole element.

It has been found that an included angle of approximately 140° is particularly advantageous as providing a radiation pattern appropriate for general use. Although in practice the included angle may lie within the range of 120° to 180°, angles approaching 180° are less advantageous with angled windscreens.

In order to aid in understanding the invention a specific embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a dipole antenna according to the invention;

Figure 2 is a side view of the antenna of Figure 1;

Figure 3 is an exploded perspective view of the dipole antenna;

Figure 4, is a side view of the antenna shown with the housing removed, and

Figure 5 is a plan view of two adjacent printed circuit boards forming the antenna elements.

Referring to the Figures, there is shown a dipole antenna 1 whose housing 2 is adapted to be adhesively secured via one face 3 of a base 4 to an inner surface of a vehicle windscreen (not shown).

Each dipole element 6a,6b is formed on a respective printed circuit board 7a,7b as a pattern of copper etched into a surface 8a,8b of the board 7a,7b. The elements 6a,6b are preferably identical which simplifies both manufacture and assembly. The boards 7a,7b are not secured within the housing 2 in a common plane. Instead, the boards 7a,7b are secured within the housing 2 between brackets 9 integral with the base 4 of the housing 2 with their planes intersecting at an included angle **A** of around 140° so that lower surfaces of the boards 7a,7b face the windscreen when the antenna 2 is mounted thereon.

Rather than use a balun, the dipole elements 6a,6b are directly connected to inner and outer feed portions 10,11 which protrude beyond the sheath 12 of a coaxial cable 13. The cable 13 is routed within the housing 2 by moulded projections 5. These projections ensure that from a feed point 14, where the inner and outer feed portions 10,11 emerge from the cable sheath 12, the cable 13 depends a short distance along a line bisecting the included angle **A** between the boards 7a,7b, before bending towards the base 4. The cable 13 is thus held in a plane substantially normal to that of the board 7a connected to the inner feed portion 10 and extends between the board 7a and the base 4 before the cable 13 exits the housing 2 at a lower edge 15 next to the face 3.

The configuration of the cable 13 as shown in Fig 4, and particularly the fact that the inner core of the cable 13 runs back between the dipole element 6a and the base 4

rather than below the element 6b, has the effect of balancing the impedance of the cable to that of the antenna, so that a separate balun can be dispensed with. This is achieved as a result of the proximity between the outer conductor 11 of the coaxial cable 13 and the element 6a connected to the inner conductor 10 that causes cancellation of currents that would otherwise occur in the outer conductor 11 due to mismatching of impedances. It will be appreciated that any currents arising in the antenna element 6a at a resonant frequency thereof will be significantly higher than, and in opposite phase to, such currents that would have arisen in the conductor 11. This effect is the same regardless of which of a number of dipoles is operating at its resonant frequency and thus enables a dual or multi-frequency antenna to be constructed in a simple manner.

Figure 5 shows the arrangement of the dipole elements 6a,6b as etched on the circuit boards 7a,7b. Both circuit boards are identical and define conductive patterns each of which comprises a portion 20 at one end that forms a termination for connection to a conductor of the cable 13, a first portion 21 that extends from the portion 20 to form one element of a first dipole operable at a first frequency and a second portion 22 that extends from the portion 20 to form one element of a second dipole operable at a second frequency. The arrangement illustrated thus provides a dual frequency antenna the operating frequencies of which, as will be well understood by one skilled in the art, are determined by the dimensions of the respective portions 21 and 22 of the conductive patterns on the circuit boards.

Likewise the matching of the impedance of the cable 13 to that of the antenna elements is determined by the dimension and arrangement of the portions of the cable that extend within the housing 2 and can be determined by one skilled in the art by trial and experiment.

However by way of example and without any limitation on the scope of the invention, for an antenna as shown in the drawings and having an included angle of 140° between the circuit boards each circuit board 7a 7b has a length 47mm and a width of 10mm.

This results in an arrangement having the relative proportions shown in the drawings where the overall length of the housing 2 is 100mm, the width is 16mm and the external height from surface 3 of base 4 to the apex of the housing is 28.5mm. The effective operating frequencies of such an antenna are 890-960mhz (GSM) and 1710-1880mhz (PCN).

The arrangement illustrated has the advantage of providing a simple and effective dual frequency antenna for use in a motor vehicle, the shape and arrangement of the antenna elements providing a uniform radiation pattern even when the antenna is used on a sloping automobile windscreen. Moreover the arrangement shown avoids the need for a balun to match the cable to the impedance of the antenna and thus is simple and inexpensive to manufacture whilst the housing provides a visually aesthetic appearance.

It will be appreciated that variations and alterations may be made to the arrangement as described without departing from the scope of the invention. Thus although the antenna elements are formed by identical circuit boards the boards need not be identical. Moreover the antenna elements need not be formed on printed circuit boards but could be formed of metal sheet or rod. Although the cable 13 is shown as exiting from the housing 2 it could terminate at a suitable connector provided at the edge 15 of the housing.

CLAIMS:

1. A dipole antenna for mounting on a vehicle windscreen, the antenna comprising a housing which includes a base surface intended for mounting on the windscreen, the housing containing first and second antenna elements each having limbs spaced from said base surface, said elements being so arranged that the limbs thereof cooperate to form dipoles having different resonant frequencies, and a coaxial cable having inner and outer antenna feeds respectively connected to said first and second elements which cable extends between said base surface and said first element in spaced relation to the latter in such a manner that electric currents that would occur in the outer feed of said coaxial cable due to mismatching of the impedances of the cable and the antenna elements are cancelled as a result of the proximity of the cable and the first antenna element.

2. An antenna as claimed in Claim 1, wherein each antenna element is formed on a separate printed circuit board.

3. An antenna according to Claim 1 or 2 wherein the respective planes of said antenna elements intersect at an included angle that defines an apex extending away from said base surface.

4. An antenna as claimed in Claim 3 wherein the said coaxial cable is routed in a plane substantially normal to the planes of the antenna elements in such a manner that the cable extends from the dipole elements at said apex, along an axis bisecting said included angle and is then angled to extend along the base of the housing below the first antenna element.

5. An antenna as claimed in Claim 3 or 4, wherein the angle included by said antenna elements is approximately 140°.

6. A dipole antenna substantially as described herein with reference to the accompanying drawings.

The Patent Office

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Claims searched: all **Date of search:** 9 August 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H1Q (QAA, QDP, QHC, QHX QJC, QKE)

Int Cl (Ed.6): H01Q (1/00 1/12, 1/32, 5/00, 5/02)

Other: Online WPI EPODOC PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2142190 A NRDC (see whole document)	
A	EP 0841715 A FUBA (see acbsrtact)	
A	EP 0113818 A Richard (see abstract)	
A	WO 98/31067 A Sansung (see whole document)	
A	WPI abstract Accession No. 98-185854/17 for JP 100041734 A (Aisin) (see abstract)	
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A	WPI abstract Accession No. 96-014116/03 for JP 070273688 A (Tsunekawa) (see abstract)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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